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Population Dynamics of Moose in Alaska: Effects of Nutrition, Predation, and Harvest

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This is a progress report on continuing research. Information may be refined at a later date.

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PROJECT TITLE: Population dynamics of moose in Alaska: effects of nutrition, predation, and harvest

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I PROGRESS ON PROJECT OBJECTIVES

OBJECTIVE 1: <u>Review literature on moose biology, indices of nutritional status, ungulate population models, predator–prey relationships, and harvest data</u>.

We continue to review available scientific literature using Internet searches.

OBJECTIVE 2: <u>Estimate and evaluate the usefulness of several reproductive and condition indices for moose in Unit 20A and investigate the influence of weather on these parameters</u>.

During the previous 5-year study we documented that reproduction and body weights were compromised at the current high, stable moose density. A 10% decline in the expected proportion of calves in the immediate postcalving population was substantial enough to contribute to the stability of the population in a measurable fashion. To derive an expected proportion of calves in a postcalving moose population, we used a value measured in a low density moose population in Unit 20E where food was not deemed a significant limiting factor to moose (Gasaway et al. 1992). We concluded that density-dependent nutritional limitation is apparent today in Unit 20A and is an expected result of maintaining moose at high density. Predation was equally important in limiting population growth during this study, and is a more apparent limiting factor.

An untested hypothesis is whether large-scale adverse weather is needed to initiate a decline in numbers and how productivity responds during such adverse weather. Boertje et al. (1996:487) questioned the validity of a long-term carrying capacity because adverse weather has initiated strong declines in moose numbers in the past, and the adverse effects of weather and predation appeared to work in a synergistic fashion to rapidly reduce population size. If adverse weather further reduces productivity, this would be clear evidence that weather-induced resource limitation is a strong secondary influence on moose populations at least at the current high density. If adverse weather acts in a density-independent fashion to reduce high and low density moose populations as per conventional wisdom, then high density populations should be left with more moose following adverse weather compared with low density populations. This would be a potential benefit of managing moose at high densities, in addition to the consumptive and nonconsumptive benefits.

Weather was favorable during this reporting period but parturition rates were similar to the lowest levels observed during the previous 8 years. We observed the lowest rates in 2001 following the relatively short prior summer of 2000. The short summer of 2000 had relatively few snow-free days and was relatively cool with a low number of growing degree days. We hypothesize that the low parturition rates observed during this reporting period was an alternate year response to the short summer of 2000, not to any apparent adverse weather during summer 2002. For example, we observed the lowest parturition rate for cows 5 years and older in 2001 (60% of 45 cows gave birth). By not giving birth in 2001, cows apparently recovered well and in 2002 produced the highest parturition rates observed in 8 years of observations (89% of 55 cows gave birth). Our hypothesis is that this elevated productivity stressed the cows because in 2003 we observed the second lowest parturition rate (63% of 68 cows gave birth). To test this hypothesis we predict a high rate in 2004 and a reduced rate again in 2005 assuming no adverse weather.

Since 1996 we have observed a parturition rate of only 64% (n = 566) and a twinning rate of only 9% (n = 364) for radiocollared moose ≥3 years old. Strong age-specific indicators of nutritional stress were even more noteworthy: 1) no 24-month-old moose (n = 38) were pregnant, 2) only 28% of 127 36-month-old moose were observed parturient, and 3) no moose observed to be less than 60 months old produced viable twins. We documented a minimum 20% decline in production with a 3.2-fold increase in density since 1978. However, the substantial increase in moose numbers has allowed far greater sustainable yields than would have been possible at the lower density.

Transrectal ultrasonography and PSPB analyses produced identical results in 1996; the only year in which both results were available. However, daily observations during the calving seasons indicate lower actual productivity in the population and less variability than indicated using ultrasound or PSPB. We use observed parturition rates as the best indicators of production in the population because they are most meaningful to the population and because of the likelihood of neonatal or intrauterine mortality in this high-density population.

Management staff have flown spring twinning rate transect surveys in central portions of the Tanana Flats for several decades without the use of radiocollared moose. Because these surveys more readily sampled moose from all age classes each year, these surveys more accurately estimated twinning rates in the population compared with our sampling of primarily young radiocollared moose. To further investigate the accuracy of twinning rate transect surveys, we tested whether differences in twinning rates could be observed with a helicopter versus a fixed-wing aircraft and found no significant differences.

Weighing short yearling moose appears to be a particularly useful and relatively inexpensive tool for evaluating moose population condition. For example, we noted substantial differences between weights in the adjacent Denali and Unit 20A populations. We also noted significant differences in weights between subpopulations within the study area. Short yearlings weighed in the Tanana Flats have weighed significantly less (about 17 kg less on average) than those in the Alaska Range foothills every year that sampling was robust. Although virtually all calves are born in the Tanana Flats, calves that move to the Alaska Range foothills in summer or autumn must have an improved energy balance relative to those remaining in the Tanana Flats. Because of the reduced moose body weights in the Tanana Flats, we have assigned the Tanana Flats a higher priority for improving moose habitat compared to the Alaska Range foothills.

We expected birthweights to provide a relatively sensitive index to winter and spring maternal and range condition and that elevated birthweights would occur among the Alaska Range foothills subpopulation, in part because short yearlings weighed significantly more in the Alaska Range foothills. However, birthweights may provide only a nonsensitive index to winter and spring conditions. For example, we found no significant differences in newborn singleton or twin birthweights with regard to dam collaring location or capture year. As expected, newborn weights in Unit 20A are relatively low compared with those from the Yukon Flats, where moose density is 85% lower and the observed twinning rate (63%) indicates a high nutritional status during ovulation. Our unique finding of a significant difference in birthweights between singleton male and female moose calves may be an indication of the relatively poor nutritional status of moose in Unit 20A.

Depth of rump fat is an index to the condition of individual moose, and potentially an index to relative condition of a moose population. We initially hoped to contrast annual differences in rumpfat depths among young moose, e.g., moose in the 10- and 22-month-old cohorts, to provide a tool to evaluate annual differences in moose condition. However, we detected no rump fat among moose in these cohorts. This lack of rump fat apparently is a sign of malnutrition at the current high densities, given that some 22-month-old moose have fat in Denali National Park.

Because short yearling bodyweights differed between the Tanana Flats and the foothills, we expected to find significant differences in adult rumpfat depths from these 2 subpopulations. However, we found no significant differences. We conclude that adult rumpfat depths are less sensitive indices of nutrient regime compared to short yearling bodyweights, presumably because rumpfat depths were gathered from a sample of adults of all ages and reproductive histories. Perhaps with a greater sample size, rumpfat depths could be used to detect significant differences in nutrient regimes in these subpopulations.

We conclude that rumpfat depth is a more expensive and, at times, less sensitive index to nutrient regime in moose compared to twinning rates and weights of short yearlings. We did find significant relationships between March rumpfat depths and reproductive status of females, but reproductive indices are much less expensive to collect than fat depths.

Mean maximum depth of rump fat was significantly greater among pregnant versus nonpregnant adult cow moose. Mean maximum depth of rump fat was also significantly greater for moose observed parturient versus those never observed with a calf and for dams giving birth to twins versus those with singletons. We also found that the fattest dams produced on average the heaviest calves. Further, as expected, regression indicated a negative relationship existed between calving date and maximum March rumpfat depth.

With the blood obtained from adult female moose in 1996 and 1997, we attempted to identify potential relationships between 22 serum constituents and rumpfat depth using multiple regression models. We conclude, at this time, that standard serum constituents are not useful indicators of rumpfat reserves in moose. In addition, the acute phase protein haptoglobin was not helpful in distinguishing stressed from nonstressed individuals.

OBJECTIVE 3: Estimate causes and respective rates of mortality among radiocollared moose of various age classes in Unit 20A.

A composite of all mortality of radiocollared moose by age from May 1996 through June 2003 indicates that annual calf survival rate was 53% for both sexes. These data are from about 80 newborn calves we collared in May 1996 and 1997 and 230 female short-yearlings we collared during March 1997–2003. We also maintained a representative sample of random adult females throughout this study. Thus most of the data for older cohorts is female-specific. This is the first reporting period in which we collared significant numbers of male short yearlings, thus we are just beginning to assess sex-specific differences in mortality rates.

The annual composite yearling survival rate from mid-May 1997 through mid-May 2003 was 82%. In comparison, the 2-year-old rate was 98%, the 3-year-old rate was 97%, the 4- through 6-year-old rate was 100%, the 7-year-old rate was 82%, the 8-year-old rate was 96%, the 9-year-old rate was 96%, the 10-year-old rate was 91%, the 11-year-old rate was 89%, the 12-year-old rate was 89%, the 13-year-old rate was 80%, the 14-year-old rate was 71%, the 15-year-old rate was 71%, the 16-year-old rate was 20%, and the 17-year-old rate was 0%. Natural mortality of random adults ≥36-months-old varied from 7 to 21% annually during this study and averaged 12.5% from 1996–1997 through 2001–2002. Yearling mortality rates averaged 13% during 1997–1998, 33% during 1998–1999, 17% in 1999–2000, 18% in 2000–2001, and 5% in 2001–2002. Thus female moose appear to be most vigorous and capable of avoiding predation from 2 years of age until reaching 7 years of age.

Wolf predation was the major cause of death among adult and yearling moose. In 28 cases where we were able to investigate the cause of death of radiocollared adults, wolves killed 17 (61%), grizzly bears killed 7 (25%), and 4 (14%) died from factors other than predation. Of 37 yearlings (12 to 24-months old) that died, wolves killed 26 (70%), bears killed 8 (22%), and 3 (8%) died from other factors.

Hunters took a nominal harvest of cows in the study area during September 1996 through 1998 and 2000 through 2002. These were the first legal cow harvests since 1974. Annual reported cow harvests during these years in Unit 20A averaged 64 cows (range 58 to 70 cows). In 2002, regulations changed and 94 cows were reported harvested. Also in 2002, a calf-specific harvest was initiated and 33 calves were reported harvested (14 male calves and 19 female calves). Regulations were changed in 2002 to encourage harvest of moose other than bulls because bull:cow ratios had declined below the objective of 30 bulls:100cows.

Simultaneous to encouraging harvest of cows and calves, new regulations were enacted to protect middle-age bulls from hunters. We noted a sharp decline in the number of bulls harvested in 2002. Only 344 bulls were reported harvested in September 2002 compared with an average annual harvest of 600 bulls the previous 6 years (range 526–677 bulls).

Sustainable harvests of moose per unit area remained at the highest level observed in Interior Alaska in recent years, despite moose having the lowest reported birth rates and reduced bull harvests. This occurs because harvest constitutes small proportions of all Interior Alaska moose populations so harvest density is strongly correlated with moose density. Unit 20A moose density is the highest in Interior Alaska, and therefore has the highest harvest density.

The 1996 and 1997 radiocollared newborn calves experienced the highest annual survival rates (52–56%) among the 7 Alaska–Yukon moose calf telemetry studies conducted to date. High calf survival undoubtedly contributes to the reduced reproductive performance of this population.

Predation was by far the major proximate cause of death in this and all previous moose calf mortality studies. Wolves killed more calves than both bear species in this study, while grizzly bears and black bears killed about equal proportions of calves. In previous moose calf mortality studies, black or grizzly bears were clearly the major predator. In addition to mortality detected using radiocollared calves, mortality prior to birth or neonatal mortality during the first 24 hours after birth apparently occurred in 7 (17%) of 42 pregnancies in 1996 and 3 (13%) of 23 pregnancies in 1997.

We studied the relationship between calf survival and birthweight, birth date, and sex for calves born during 1996 and 1997. These data indicate that all calves are equally vulnerable to mortality factors common to this first month of life. However, modeling indicated increased mortality of lightweight calves at older age classes. In addition, preliminary analysis of the data supports the hypothesis that no relationship exists between dam condition (age, fat reserves, and collaring location) and mortality of their calves within the range of values observed.

OBJECTIVE 4: Analyze movement data for moose captured within the study area. Specifically, we will investigate migration patterns, dispersal of subadults, home range sizes of adult moose, and calving related movements.

Kalin Kellie completed fieldwork for her Master's degree on moose movements. Kalin has compiled available data from the prior 7 years of work and flew additional flights during this reporting period. Kalin completed a draft of the first chapter of her thesis on fidelity to birth sites and movements immediately prior to calving. She is currently analyzing data on moose migration, and home range size for the final chapter of her thesis. She will also publish a paper on dispersal of young moose from their dam's home range and a comparison of Unit 20A dispersal data collected at both low and high moose density.

We hypothesize that dispersal rates of subadult moose and home range size of adults will be similar to those reported by Gasaway et al. (1980) when the Unit 20A moose population was at a low-density. Further, we hypothesize moose movements prior to calving will reflect an antipredation strategy.

OBJECTIVE 5: Summarize existing statewide reproduction and population data for moose. Currently, there is a need for a single consolidated source for past moose survey information as well as other data collected on condition or reproductive parameters of moose populations within the state.

No progress was made on this objective because Mark Keech was reassigned to Unit 19D moose research studies.

II SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN THIS PERIOD

JOB 1: Continue literature review on (1) moose biology and ecology at high densities; (2) indices to nutritional status of ungulates; (3) models of ungulate population dynamics; (4) predator–prey ratios in relation to population dynamics of moose, caribou, sheep, wolves, and grizzly bears; (5) predator/prey relationships in multi-prey, multi-predator systems; and (6) population and harvest data on moose, caribou, sheep, wolves, and bears in Unit 20A.

I routinely reviewed literature as necessary to remain current on relevant aspects of moose biology. Also, Kalin Kellie completed an exhaustive review of the literature on moose movements for her Master's degree. I also attended the 39th North American Moose Management Conference to meet those most involved with moose research and management. I estimated that 11 person-days were spent on this job during this reporting period.

JOB 2: Estimate and evaluate the usefulness of several reproductive and condition indices for moose in Unit 20A and investigate the influence of weather on these parameters.

In early March 2003 we recaptured 2 female 81-month-old moose, 14 female 69-month-old moose, and five 57-month-old moose. We replaced the aging ATS collars that were deployed when these moose were 9 months old. We also recollared 3 older adults that had initially been randomly collared adults. We used blood samples from 22 of these moose to estimate a pregnancy rate of 77% from PSPB values. We had insufficient funds to measure rumpfat depths. We saved funds by using an R-22 helicopter for transportation to deploy collars.

We also radiocollared 11 female and 11 male short-yearling moose and weighed these moose. Females averaged 148 kg and males 160 kg. As in previous years, capture sites were divided equally between the Tanana Flats and Alaska Range foothills. During the first 5 years of capture, weights were consistently significantly higher in the foothills (sample sizes totaled 40 or more short-yearlings, 1996–2000 cohorts). This trend continued in the 2001 cohort although we reduced sample size to 20 female short yearlings to allow funding for recollaring adults. During this reporting period, we began collaring male short yearlings. This will change the emphasis from evaluating production of each new cohort to estimating mortality rates of male cohorts, which previously has not been studied. Next year we may collar 20 male short yearlings to improve the sample size of males, while continuing to recollar known-age female adults and monitoring production and mortality of these cohorts. We captured 46 moose during this reporting period; 1 died about 4 days later and 1 died about 18 days later. These deaths may have been related, in part, to capture, but moose in this area are nutritionally stressed compared to lower density moose populations so deaths caused by factors other than predation are more common here. Predators were not involved.

Approximately 30 fixed-wing radiotracking flights were flown between mid-May and mid-June 2003 to observe parturition and twinning rates of 116 radiocollared moose greater than 2 years old. Of 68 cows ≥5-years old, 43 (63%) were observed with newborn calves during alternate day flights. Twinning rate of these 43 radiocollared cows was 7%. Twinning rates from aerial transect surveys totaled 9% (*n* = 58 cows with calves). The median calving date was 22 May, similar to previous years. Newborn calves were observed from 12 May through 10 June. Data on weather patterns will be compiled when available from the National Oceanic and Atmospheric Administration.

JOB 3: <u>Estimate causes and rate of mortality among radiocollared moose of various age classes in Unit 20A</u>.

To assess causes and rates of mortality of moose within the study area, all radiocollared moose (approximately 150 to 170 moose) were tracked at least monthly with fixed-wing aircraft during this reporting period. Flights were most frequent in the summer. In addition, a helicopter (R-22 or R-44) was deployed to recover collars and investigate causes of death of 15 collared moose.

JOB 4: <u>Analyze movement data for moose captured within the study area. Specifically, we will investigate migration patterns, dispersal of subadults, home range sizes of adult moose, and calving related movements.</u>

Kalin Kellie radiotracked a subsample of about 25 collared moose at least monthly as part of the dispersal, home range, and migration studies. In addition, she organized the calving studies and radiotracked most of the 116 adult moose from mid-May through mid-June or until they calved. She also assisted with all phases of the March collaring work.

JOB 5: <u>Summarize existing statewide reproduction and population data for moose. Currently, there is a need for a single consolidated source for past moose survey information as well as other data collected on condition or reproductive parameters of moose populations within the state.</u>

No progress was made on this objective because Mark Keech was reassigned to Unit 19D moose research studies.

JOB 6: <u>Write progress reports and publish a final report. Also, incorporate results into appropriate Alaska wildlife planning, discussions, and management activities</u>.

Data collected from this project are being used in Unit 20A moose management reports, advisory committee meetings, Board of Game meetings, discussions with the public regarding harvest opportunities, and discussions with the Department of Natural Resources regarding the need to improve habitat in Unit 20A using burns. Results to date were also presented at the annual meeting of the Alaska Chapter of the Wildlife Society in Juneau in April 2003 and at the 39th North American Moose Management Conference in Jackson Hole, Wyoming in May 2003.

III ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THIS SEGMENT PERIOD

No additional work was accomplished.

IV PUBLICATIONS

We presented 4 papers at formal meetings and these papers are being peer reviewed in preparation for publication (see Appendix for abstracts). We also published an informal paper in the January issue of *The Moose Call* entitled "Managing Moose at High Density in Interior Alaska" (see Appendix).

V RECOMMENDATIONS FOR THIS PROJECT

The opportunity exists to switch the emphasis from females to males when collaring short yearlings. No data exists on natural mortality rates of male moose older than calves.

VI APPENDIX

Managing High Density Moose in Interior Alaska: Elevated Yields Despite Reduced Productivity

RODNEY D BOERTJE[1], KALIN A KELLIE[1], C TOM SEATON[1], MARK A KEECH[1], DONALD D YOUNG[1], AND BRUCE W DALE[2]. 39th North American moose management conference, Jackson Hole, Wyoming, May 2003.

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Sustained yields of moose in Unit 20A during 1996–2001 were the highest reported in Interior Alaska despite declines in initial productivity to the lowest levels reported in North America among continental, wild moose. Annual harvest ranged between 54 to 61 moose/1000 km^2 from this stable, high-density population of 12,150 moose in 13,044 km^2. Wolf control contributed to this high density. In contrast, sustained yields of 0–13 moose/1000 km^2 were reported in low-density systems without manipulated predator populations. During our 7-year study (1996–2002), we documented: (1) delayed reproduction until moose reached 3 years of age, (2) an average of 9% twinning among observed parturient moose in contrast to 28% to 63% among low-density moose, and (3) an average of 31% calves in the annual immediate postcalving population in contrast to 41% in a low-density moose population. Given the near stability of the population, average annual mortality must have also equaled about 31% of the postcalving population. Sustained yields to humans totaled 5% of the postcalving population each year. High yields per unit area

were available because of high moose density and survival. Yield steadily increased with moose density in contrast to the classic yield curve. Predators took only 19% of the postcalving moose population in contrast to 31% and 41% in 2 studies of low-density moose. Wolves were the dominant predator in Unit 20A killing many moose that otherwise would live and reproduce, as evidenced by increased calf survival during 2 wolf control programs at low and high moose density. Favored browse was declining; 77% of browsed plants were broomed in Unit 20A in contrast to 21% and 54% on 2 lower density moose ranges. We recommend rejuvenating habitat with fire to increase initial moose productivity 5%. Potential benefits could include doubling current annual yields.

Initial Use of Moose Calf Hunts to Increase Yield in Interior Alaska

DONALD D YOUNG JR AND RODNEY D BOERTJE. 39th North American moose management conference, May 2003, Jackson Hole, Wyoming.

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The Alaska Board of Game recently authorized hunts specifically for calf moose (*Alces alces*) in Game Management Unit (Unit) 20A to help meet demand for moose for human consumption. Unit 20A has the highest moose density in interior Alaska (12,150 moose in 13,044 km^2 of moose habitat). High harvest rates (21–26%) of bulls from 1995 to 1999 resulted in bull:cow ratios declining below the management objective of 30:100. As a result, unitwide antler restrictions were implemented to reduce the harvest of bull moose to sustainable levels. Calf hunts were implemented to partially compensate for the reduction in the harvest of bulls. In 2002, 300 drawing permits were made available in 7 different hunt areas with the allocation of permits based on estimated moose densities within individual hunt areas. Two hundred and seventy-four permits were issued and 108 hunters reported taking 33 calves (14 male and 19 female). The harvest accounted for about 1.3% (33/2500) of the estimated prehunt calf population and 7% (33/471) of total reported harvest. In contrast, the harvest of bulls accounted for about 14% (344/2500) of the prehunt bull population and 73% (344/471) of the total harvest. The harvest of cows accounted for about 1.2% (94/7600) of the prehunt cow population and 20% (94/471) of the total harvest. The calf harvest contributed only marginally to meeting the Unit 20A harvest mandate of 500–720 moose. However, I believe harvest of calves may be increased to approximately 130 (20% of an expected total harvest of 650) through registration and late season hunts. The calf hunts were contentious, particularly among local citizen's advisory committees and hunters. Primary arguments against the calf hunts were philosophical, cultural, and biological in nature. Biological justification for calf hunts includes: 1) potentially higher yields; 2) reduced hunting pressure on bulls; and 3) harvesting calves emulates nature more closely than a "bulls only" harvest strategy. Gaining public acceptance of calf hunts will likely be a long-term and challenging but worthwhile endeavor. I recommend the use of calf hunts as a management tool to increase harvest and yield, particularly in areas with high moose densities and harvest mandates.

Moose Movements During Calving Season

KALIN A KELLIE[1], RODNEY D BOERTJE[2], PATRICIA DOAK[1], AND MARK A KEECH[2]. [1]University of Alaska Fairbanks, 211 Irving Bldg I, Fairbanks, AK 99775; [2]Alaska

Department of Fish and Game, 1300 College Road, Fairbanks, AK 99701-1599. Alaska Chapter of the Wildlife Society annual meeting, 9–10 April 2003, Juneau, Alaska.

The moose population in Game Management Unit 20A is currently at high density; reproductive parameters indicate moose are experiencing poor nutrition. Knowledge of moose movements in spring, when moose are at their lowest annual level of nutrition, may help managers to prioritize areas for habitat improvement. Each spring from 1996–2002 locations of radiocollared female moose were obtained in Unit 20A as part of a long-term parturition study. Sixty-six of these moose were located in successive years and examined for site fidelity. We measured the distance between locations in successive years for 181 moose-year pairs to determine the level of site fidelity. In addition, we examined three potential reasons for site fidelity at the population level: return to birth sites, movements timed to photoperiod and movements timed to green up. Female moose exhibited strong fidelity to areas used during previous calving seasons. Moose traveled a median distance of 46.9 km (range 4.3 km to 168.0 km) between summer and winter range each year, yet individuals returned within a median distance of 281 m (range 19 m to 4,416 m) from their locations recorded the previous spring. Birth sites were not reused in subsequent years: successive birth sites were a median distance of 5.2 km apart (range 0.05 km to 33.7 km), 82% were over 1 km apart. Neither photoperiod (P = 0.99) nor green up (P = 0.53) significantly explained the timing of site fidelity in successive years at the population level. Site fidelity of individuals in this high-density population may intensify use of early spring habitats and possibly deplete resources in these areas. Further investigations should focus on forage availability and abundance in areas of site fidelity. We suggest that habitat manipulation may be extremely effective and efficient in areas with dependable concentrations of moose experiencing increased nutritional demands.

Relationships Between Removal of Browse Biomass and Moose Productivity and Density

C Tom Seaton[1], Rodney D Boertje[1], Thomas F Paragi[1], Craig L Fleener[2], Steve D DuBois[3], and Brad Griffith[4]. 39th North American moose management conference, Jackson Hole, Wyoming, May 2003.

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We studied removal of browse biomass by moose in 4 areas of Interior Alaska, 2000–2003. Our purpose was to document landscape-scale patterns of browse removal over a gradient of moose productivity and density. We estimated the proportion of current annual growth that was removed based on bite diameters and diameter-mass regressions specific to each browse species. In late winter we sampled willow (*Salix* spp.), quaking aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), and paper birch (*Betula papyrifera*) with current annual growth between 0.5 m and 3.0 m above the ground. We estimated browse removal by moose to be 9–42% of current annual growth at the landscape-scale. Browse removal by moose was inversely correlated (r^2 = 0.94) with moose twinning rate (range 6–63%) and correlated (r^2 = 0.89) with moose density (range 0.15–1.1 moose per

square kilometer). We documented browse removal estimates to (1) evaluate the need for habitat rejuvenation in an area of high density; (2) evaluate habitat suitability where an increase in moose density was proposed; and (3) provide relative baseline information linking the fields of moose habitat biology and population biology.

Managing Moose at High Density in Interior Alaska

KALIN KELLIE AND RODNEY D BOERTJE. *The Moose Call* 16:7–8. January 2003.

Super Cub pilot Troy Cambier and I stared intently out the window as we began to circle our first collared moose of the day. “Nope,” said Troy, “I think she’s alone.” We looked carefully at the ground surrounding the moose and made one more turn. Regretfully, Troy punched in the location and I wrote down the information. This would probably be the last flight for the calving study this spring. It was June 17, and we hadn’t seen a new calf in four days. We began flying on May 13 with the challenging task of checking 103 collared cow moose for new calves every 48 hours. Over the next few weeks, cows were dropped from the list as they gave birth and their birthsite locations recorded. We were down to 28 cows now, and most of these had just reached three years of age and were probably not pregnant.

The moose population we are monitoring is in central Game Management Unit 20A, just south of Fairbanks, Alaska. The population is at a very high density (1.1 moose/km^2 in a 6700-km^2 area) relative to other rural areas of Alaska and has been stable for a decade. Unique circumstances that lessen wolf and bear predation have contributed to this high and stable moose density. Proximity to Fairbanks traplines increases wolf harvest. Although wolf numbers are relatively high, trapping keeps winter wolf predation low enough to be sustained by this moose population. Bear predation during the calving season is also relatively low. Just prior to calving, high-elevation moose migrate out of grizzly bear habitat to lower, swampy elevations where grizzly bears are almost absent and black bears are few.

The central Unit 20A moose population has supported a harvest of about 400 moose each year for seven years and therefore is an important meat resource for many Alaskans. In an attempt to keep it that way, Fish and Game uses spring calving surveys and late fall population surveys to carefully monitor changes in the population. In a state where the majority of moose populations are on the decline, managers want up-to-date information when making harvest decisions for Unit 20A.

Rod Boertje and Mark Keech began collaring moose and conducting calving surveys in 1996 as part of a calf mortality study. Calving flights have continued every spring through 2002. The composition of the collared moose sample makes this study unique. Forty ten-month-old calves have been collared every year since 1997. Almost all of the 160 collared cows currently on the air were first collared as ten-month-old calves, giving us excellent long-term information on reproduction of individual moose of various known ages.

In seven years of monitoring calving, we’ve discovered that current moose reproduction in Unit 20A is the lowest ever documented for a mainland population. First of all, the age of first reproduction in this population is later than most. While two-year olds commonly give birth in other moose populations, in Unit 20A there is no calving among two-year-olds and only 30 percent are giving birth for the first time as three-year-olds. Twinning rate surveys show that twinning in Unit 20A is also unusually low. Many moose populations at lower density have twinning rates ranging from 25 to 60 percent, as did the Unit 20A moose population when moose density was low. But recently in Unit 20A, we have seen annual values average less than 10 percent and range from 0 percent to 20 percent. Finally, the average cow giving birth to twins is older in 20A than in most populations. It is extremely rare for a cow less than five years old to be in good enough condition to have twins. In fact, from 1996–2002, not a single collared four-year-old was observed with twins.

All of these reproductive clues point toward poor nutrition. Studies of moose populations overextending their range usually name winter moose browse as the limiting factor. Tom Seaton, a graduate student collaborating with Fish and Game, has been working on that question. Using measurements from the range of three moose populations in Interior Alaska, he has found a strong relationship between the amount of broomed moose browse and twinning rates. Of the three areas used in the study, Unit 20A had the poorest range condition and the lowest twinning rates.

According to census data from annual surveys, the Unit 20A moose population has remained stable for a decade of mild winters. However, given that the population is on a low nutritional plane, the moose are susceptible to random weather fluctuations. For instance, in harsh winters when snow is deep, moose expend huge amounts of energy walking through deep snow, with the end result being starvation and elevated wolf predation. Many high-density moose populations, including the Unit 20A population about 35 years ago, have been nudged into a downward spiral by a series of deep-snow winters. But harsh winters are not the only concern. A comparison of calving data and summer weather patterns from the past seven years shows that summer length and average temperature may also be a concern.

Meteorologist Rick Thoman from the National Weather Service in Fairbanks uses "growing degree-days" as an index of summer length and temperature. Starting with March 1, he subtracts 50 degrees from the daily high temperature for every day of the summer. The index for the summers of 1995 through 1999 was around 1000. In summer 2000 the growing degree-days for Fairbanks summed to 754: the lowest seasonal total since 1965. During that summer, moose had trouble gaining enough fat to get pregnant. The following spring, calving rates were the lowest recorded for the study period. Only 12 percent of three year olds calved that year and the calving rates for adults aged 5 years and older dropped 20 percent. The following summer, conditions improved and the total growing degree-days for 2001 was back up to 928: average for the Fairbanks area. Now in spring 2002 we are seeing a rebound in the calving rates. Three year olds are back up to 30 percent calving and adults have rebounded from 60 percent calving to 90 percent. Part of this rebound is probably due to improved body condition of the cows that did not give birth the previous year. Nevertheless, the large difference in calving between the two years indicates that moose under nutritional stress fall to an even lower body condition following short, cold summers.

Currently, the Alaska Department of Fish and Game is working toward improving moose habitat in Unit 20A to help reduce nutritional constraints on the moose population. In the boreal forests of Alaska, habitat improvement usually translates into wildfire. Fires unlock nutrients tied up in spruce needles and moss, stimulating a profusion of shrubs and young saplings preferred by moose. Two wildfires burned in summer 2001 and created 200,000 acres of new habitat potential for moose in Unit 20A. Plans are also in place for additional prescribed burns this summer. Although the burns are an encouraging development, most Interior Alaska burn areas require at least 5 years to become quality moose habitat. If we continue to have mild winters and long summers for the next few years, these burns may provide some much-needed relief for the deteriorating winter browse supply. Hopefully, the increase in available browse will help to prolong this remarkable period of high moose density in Unit 20A.

VII PROJECT COSTS FOR THIS SEGMENT PERIOD

FEDERAL AID SHARE $73,000 STATE SHARE $36,000 = TOTAL $109,000

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